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Type of Organization: College or University

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Project Title: Environmental Behavior of Polybrominated Diphenyl Ethers

Project Category: Emerging Issues

Rank by Organization (if applicable): 0

Total Funding Requested (\$): 219,937 **Project Duration:** 2 Years

Abstract:

We propose to provide a coherent, self-consistent data set of polybrominated diphenyl ethers (PBDEs) in air, water, sediments, and fish from Lake Ontario that can be used to determine current and historical levels and partitioning behavior among these media. These data will allow us to construct a simple mass budget of PBDEs for one of the Great Lakes, and will provide partition coefficients that are necessary for modelers to estimate the distributions of PBDEs in the other Great Lakes. Thus this study will provide a foundation for understanding the environmental distributions, behavior and fate of PBDEs in the Great Lakes, and enable EPA and the States to move towards managing this emerging issue.

Geographic Areas Affected by the Project**States:**

<input type="checkbox"/> Illinois	<input checked="" type="checkbox"/>	New York
<input type="checkbox"/> Indiana	<input type="checkbox"/>	Pennsylvania
<input type="checkbox"/> Michigan	<input type="checkbox"/>	Wisconsin
<input type="checkbox"/> Minnesota	<input type="checkbox"/>	Ohio

Lakes:

<input type="checkbox"/> Superior	<input type="checkbox"/> Erie
<input type="checkbox"/> Huron	<input checked="" type="checkbox"/> Ontario
<input type="checkbox"/> Michigan	<input type="checkbox"/> All Lakes

Geographic Initiatives:

<input type="checkbox"/> Greater Chicago	<input type="checkbox"/> NE Ohio	<input type="checkbox"/> NW Indiana	<input type="checkbox"/> SE Michigan	<input type="checkbox"/> Lake St. Clair
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Primary Affected Area of Concern: Niagara River, NY**Other Affected Areas of Concern:** Eighteenmile Creek, NY
Oswego River, NY
Rochester Embayment, NY

For Habitat Projects Only:**Primary Affected Biodiversity Investment Area:** Not Applicable**Other Affected Biodiversity Investment Areas:**

Problem Statement:

Polybrominated diphenyl ethers (PBDEs) are compounds that are used as flame-retardants in many commercial products from textiles to building materials, but mostly electronics (WHO 1994). The chemical structure is similar to that of polychlorinated biphenyls (PCBs) with the exception of bromine constituents instead of chlorine constituents and an ether bond connecting the two phenyl rings. There are 209 possible congeners, but PBDEs are produced predominantly with four to ten bromines, limiting the number of congeners that are present in the environment. Because of the structural similarities between PBDEs and PCBs, their physical-chemical properties are also similar. Vapor pressure, water solubility and octanol-water partition coefficients for PBDEs are all on the same order of magnitude as PCBs, so it is expected that they behave similarly in the environment, but the appropriate data have not been collected to test this assumption.

Although PCBs have been banned since the mid 1970's, PBDEs have been produced at an increasing rate over the past twenty years (WHO 1994; WHO 1997). As a result, environmental levels have increased over this same time period. Concentrations of PBDEs in human mother's milk have increased >50 fold in women from Sweden (Marsh et al. 1999). The most likely mode of exposure in these women was consumption of contaminated fish. Fish make up a large part of the Swedish diet and because of the physical-chemical similarities to PCBs, it is expected that PBDEs do bioaccumulate. Also similar to PCBs, PBDEs have been shown to induce learning disabilities in mice (Eriksson et al. 1998). Thus the environmental fate of PBDEs is of special interest to scientists, managers and the public around the Great Lakes.

Polybrominated diphenyl ethers have been found in all compartments of the environment, but little is known of their partitioning among these compartments. Great Lakes managers, regulators and modelers need the ability to predict environmental measurements (and preferably a self-consistent data set rather than data from different sources) as well as partitioning data to build models predicting the behavior of this emerging issue.

Lake Ontario has historically been the most impacted of the Great Lakes, and therefore may be susceptible to contamination by PBDEs. While it is not possible to obtain enough data for an entire mass balance of Lake Ontario, this project will provide sufficient data to construct a simple mass budget. The data will also be used to calculate partition coefficients for modeling purposes. Such data would be necessary for any modeling efforts of PBDEs in Lake Ontario and the other Great Lakes by EPA and others.

References:

Eriksson, P., E. Jakobsson, et al. (1998). "Developmental Neurotoxicity of Brominated Flame-Retardants, polybrominated diphenyl ethers and tetrabromo-bis-phenol A." *Organohalogen Compounds* 35: 375-377.

Marsh, G., J. Hu, et al. (1999). "Synthesis and Characterization of 32 Polybrominated Diphenyl Ethers." *Environmental Science and Technology* 33(17): 3033-3037.

WHO (1994). *Environmental Health Criteria 162: Brominated Diphenyl Ethers*. Geneva, Switzerland, World Health Organization.

WHO (1997). *Environmental Health Criteria 192: Flame Retardants: A General Introduction*. Geneva, Switzerland, World Health Organization.

Proposed Work Outcome:

We propose to sample the air, water, sediment and lake trout of Lake Ontario to provide baseline data for calculating partitioning behavior among these compartments to be used in modeling efforts. Atmospheric gas phase and dissolved phase water concentrations will be compared to investigate direction and magnitude of air-water exchange fluxes. Dissolved and particulate water phase concentrations will be compared to calculate partition coefficients. Dissolved water phase and fish concentrations will be compared to calculate bioconcentration factors. Sediments will be dated using ²¹⁰Pb (by contract) and analyzed to determine the burial rate of PBDEs and to examine the historical accumulation to be compared with production over the same time period. Particular attention during sampling will be paid to Areas of Concern such as the outfalls of the Niagara and Oswego Rivers and Eighteen Mile Creek and the Rochester Embayment.

This information will be available to modelers to enable them to include PBDEs in their efforts on Lake Ontario, and to managers so that they can determine the level of concern that PBDEs present in the management of Lake Ontario and perhaps the Great Lakes as a whole.

Lake trout will be obtained from the 2000 or 2001 USGS National Biological Division collection campaign, collection by the New York State Department of Natural Resources or some combination of the two agencies. Water and air samples will be taken simultaneously aboard the RV Lake Guardian during the summer of 2001 from cruise tracks around Lake Ontario. Air samples will consist of 12-hour high volume air samples employing a glass fiber filter to collect the particle phase and polyurethane foam plug to collect the gas phase. Water will be pumped through a glass fiber filter to collect the particle phase and then through an XAD resin cartridge to collect the dissolved phase. Water samples will be taken at the midpoint of the 12-hour air sampling period. Sediment cores will also be collected aboard the RV Lake Guardian during the summer of 2001. We will have the sediments dated using ²¹⁰Pb. A total of ten paired air and water samples, twenty lake trout and two sediment cores will be collected and analyzed for PBDEs. Time and money constraints may alter the number of samples.

There are two GC/MS methods for analysis of PBDEs, electron impact (EI) ionization and electron capture negative ionization (ECNI) mass spectrometry. Electron impact mass spectrometry creates fragment ions where there are potential interferences with PCBs, so either the PCBs must be removed or isotope ratios must be carefully monitored. The second method, ECNI, is highly specific and sensitive to the bromine in the PBDE structure, and this is important as a confirmatory technique. Since PBDEs are a complex mixture, the ability to confirm them is important from a quality assurance perspective. The instrumentation for this technique is not common to most laboratories. Our environmental chemistry laboratory at the University of Minnesota is fortunate to have the capability of both EI and ECNI mass spectrometry.

Project Milestones:**Dates:**

Project Start	10/2000
Begin Fish Analysis	11/2000
Water, Air and Sediment Sampling	04/2001
Begin Water, Air and Sediment Analysis	05/2001
Water, Air and Sediment Sampling	08/2001
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Final Report to EPA	09/2002
Project End	09/2002

☐ Project Addresses Environmental Justice

If So, Description of How:

☐ Project Addresses Education/Outreach

If So, Description of How:

Project Budget:**Federal Share Requested (\$)****Applicant's Share (\$)**

Personnel:	78,979	0
Fringe:	24,213	0
Travel:	6,120	0
Equipment:	1,000	0
Supplies:	38,190	0
Contracts:	3,200	0
Construction:	0	0
Other:	0	0
Total Direct Costs:	151,702	0
Indirect Costs:	68,235	0
Total:	219,937	0
Projected Income:	0	0

Funding by Other Organizations (Names, Amounts, Description of Commitments):

Description of Collaboration/Community Based Support:

This project will be conducted collaboratively with Dr. Deborah L. Swackhamer in the same Division as Dr. Simcik. Dr. Swackhamer's responsibility will be to analyze the fish and sediments, while Dr. Simcik will be responsible for the air and water analysis. Both Drs. Simcik and Swackhamer will be responsible for data interpretation and mass budget formulation.